

ENGINEERING DEPARTMENT
TECHNICAL REPORT

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July 25, 1967

SATURN IB PROGRAM

TEST REPORT
FOR

PRESSURE SWITCH

Hydra-Electric Company Part Number 32067

NASA Drawing Number A75M04044-HPS-2

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TEST REPORT

FOR

PRESSURE SWITCH

Hydra-Electric Company Part Number 32067

NASA Drawing Number A75M04044-HPS-2

ABSTRACT

This report presents the results of tests performed on three specimens of Pressure Switch A75M04044-HPS-2. The following tests were performed:

- | | |
|-------------------------|--------------|
| 1. Receiving Inspection | 6. Vibration |
| 2. Proof Pressure | 7. Salt Fog |
| 3. Functional | 8. Explosion |
| 4. Low Temperature | 9. Cycle |
| 5. High Temperature | |

The actuation pressure of specimen one was out of tolerance during the initial functional and cycle tests and after the high temperature test.

The actuation pressure of specimen two was out of tolerance during the initial functional and after the high temperature, vibration, explosion, and cycle tests.

The actuation pressure of specimen three was out of tolerance during the initial functional and after the salt fog test. The unit was not adjustable to the minimum required actuation pressure during the adjustability tests performed after the salt fog and cycle tests.

N 67 39990

TEST REPORT

FOR

PRESSURE SWITCH

Hydra-Electric Company Part Number 32067

NASA Drawing Number A75M04044-HPS-2

July 25, 1967

FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS 8-4016, Part VII, CWO 271620.

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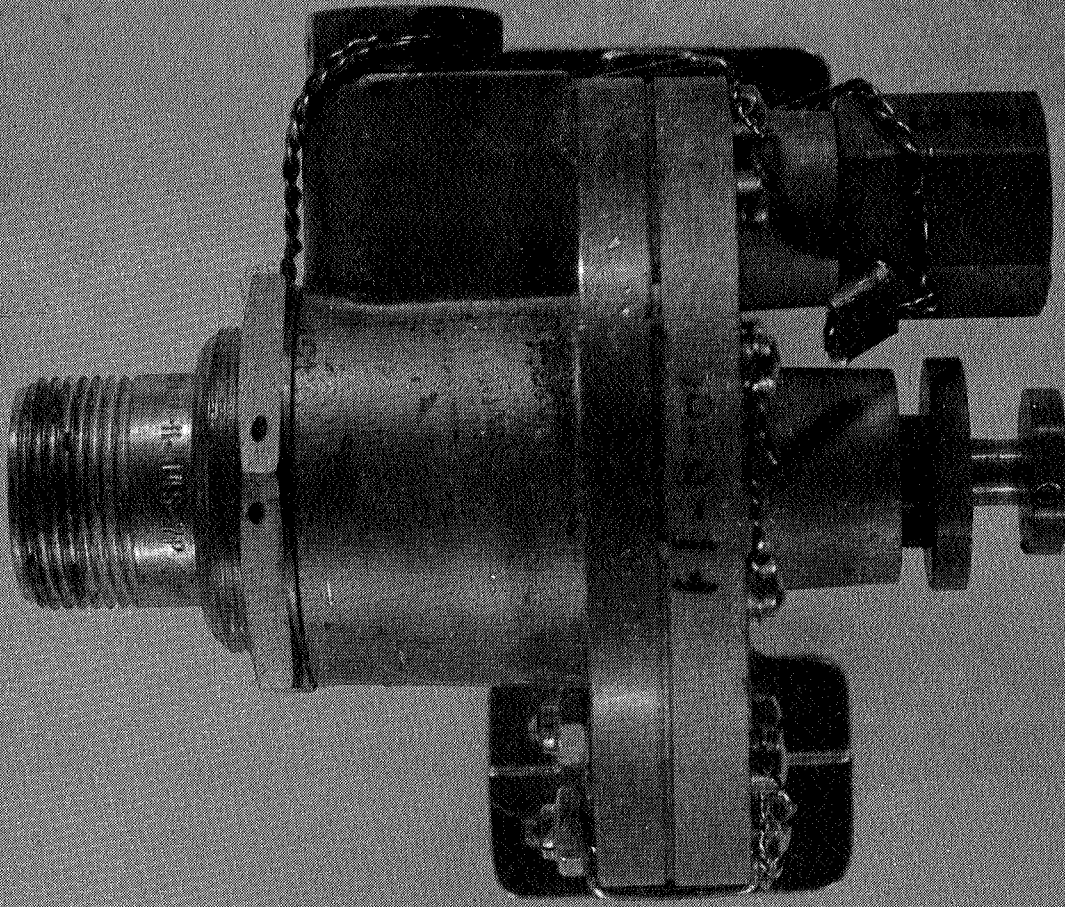
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HYDRA-ELECTRIC COMPANY

PRESSURE SWITCH

FO-1107

PRESSURE SWITCH #75TT40 PS-2

CHECK SHEET
FOR
PRESSURE SWITCH

MANUFACTURER : Hydra-Electric Company, Burbank, California
MANUFACTURERS PART NUMBER: 32067
NASA PART NUMBER: A75MO4044-HPS-2
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

- A. OPERATING MEDIA : GH_2 , GHe, GN_2
- B. OPERATING PRESSURE: Actuates on decreasing pressure at 8.0(± 0.08) psig, deactuates at or before 8.80 psig on increasing pressure.
- C. ADJUSTABLE RANGE: Field adjustable to ± 10 percent of factory setting.
- D. LEAKAGE: 2.9×10^{-4} standard cc He/sec/inch of seal (maximum) at a pressure differential of 1 atmosphere.
- E. PROOF PRESSURE: 250 psig
- F. CONTACT READING: 5 amperes, dc resistive

II. CONSTRUCTION (MECHANICAL)

- A. PRESSURE ELEMENT: Spring-return pneumatic piston
- B. PNEUMATIC CONNECTION: AND 10050-4
- C. WEIGHT: 14 ounces

III. CONSTRUCTION (ELECTRICAL)

- A. CONNECTOR: 7P (mates with MS 3106-14S-7S)
- B. CONTACT VOLTAGE DROP: 0.300-vdc maximum at rated load

IV. ENVIRONMENTAL CHARACTERISTICS (MANUFACTURERS SPECIFICATION)

TEMPERATURE RANGE: $+30$ to $+130^\circ\text{F}$

V. LOCATION AND USE

- A. LOCATION: LH_2 transfer system and LH_2 storage tank pressurization subsystem
- B. USE: Automatic loading sequence circuit for the liquid hydrogen transfer system.

TEST SUMMARY

PRESSURE SWITCH 75M04044-HPS-2

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Receiving Inspection	1,2,3	Visual inspection	To determine if specimens conform with applicable drawings and specifications	Satisfactory	
Proof Pressure Test	1,2,3	250 psig for 10 minutes	Maintain 250 psig	Satisfactory	
Initial Functional Test					
Actuation and Deactuation	1,2,3	Deactuate on increasing pressure at or before 8.80 psig; actuate on decreasing pressure at 8.0 (+0.08)psig	Actuate and deactuate test specimens at specified levels	Unsatisfactory	Improper actuation pressure
Contact Voltage Drop	1,2,3	Apply a 5-ampere, 28 vdc resistive load across closed contacts	Voltage drop shall not exceed 300 millivolts	Satisfactory	
Insulation Resistance	1,2,3	500 vdc applied between non-connected pins and between each pin and switch case	Insulation resistance not less than 20 megohms	Satisfactory	
Dielectric Strength	1,2,3	1000 vac (rms), 60 cps applied between non-connected pins and between each pin and switch case	Leakage current not greater than 5 milliamperes	Satisfactory	

TEST SUMMARY (CONTINUED)

PRESSURE SWITCH 75MO4044-HPS-2

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Seal Leakage Test	1,2,3	Pressure differential of 1 atmosphere	Leakage rate shall not exceed 2.9×10^{-4} standard cc of helium/second/inch of seal	Satisfactory	
Adjustability Test	1,2,3	Adjustable to ± 10 percent of specified actuation pressure	Actuate at 8.80 psig or more (maximum setting); actuate at 7.20 psig or less (minimum setting)	Satisfactory	
Low Temperature Test	1 & 2	Stabilize at 30°F, perform a functional test at low temperature, and return to ambient conditions	Determine whether low temperature causes degradation or deterioration of the specimens	Satisfactory	
High Temperature Test	1&2	Stabilize at 130°F, perform a functional test at high temperature, and return to ambient conditions	Determine whether high temperature causes degradation or deterioration of the specimens	Satisfactory	
Vibration Test					
Resonant Frequency	1 & 2	Vibrate specimens for 15 minutes from 5 to 2000 to 5 cps at specified input levels	Determine resonant frequencies of test specimens	Satisfactory	
sinusoidal Sweep	1	Vibrate specimens for 20 minutes from 10 to 2000 to 10 cps at specified input levels	Determine operating ability during vibration and after being subjected to a vibration environment	Satisfactory	
	2			Unsatisfactory	Improper actuation pressure

TEST SUMMARY (CONTINUED)

PRESSURE SWITCH 75MO4044-HPS-2

Environment	units	Operational Boundary	Test Objective	Test Results	Remarks
Random Excitation	1	Vibrate specimens for 5 minutes at specified input levels	Determine operating ability during vibration and after being subjected to a vibration environment	Satisfactory	Improper actuation pressure
	2			Unsatisfactory	
Salt Fog Test	1	5% by weight mixture salt solution, maintain for 240 hours at 95°F	Determine performance after being subjected to salt fog environment	Satisfactory	Improper actuation pressure
	3			Unsatisfactory	
Explosion Test	1	32% by volume hydrogen, 160°F at 13.1 psig	Operate switch in explosive atmosphere	Satisfactory	Improper actuation pressure
	2			Unsatisfactory	
Cycle Test	1 & 2	Actuate and deactuate each specimen for 5000 cycles	Determine effect of continuous operation on specimen performance	Unsatisfactory	Improper actuation pressure

SECTION I

INTRODUCTION

1.1 SCOPE

This report presents the results of tests that ~~were~~ performed to determine if Pressure Switch 75M04044-HPS-2 meets the operational and environmental requirements of the John F. Kennedy Space Center. A summary of the test results is presented on pages viii through x.

1.2 ITEM DESCRIPTION

1.2.1 Three specimens of Pressure Switch 75M04044-HPS-2 ~~were~~ tested. The switches are manufactured by Hydra-Electric Company as vendor part number 32067. The switch is adjusted to operate on increasing pressure at or before 8.80 psig and on decreasing pressure at 8.0 psig with an adjustable range of 10 percent.

1.2.2 The switch is mounted by means of two support brackets attached to the switch housing. The switch will be used in an automatic loading sequence circuit for a liquid hydrogen transfer system.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Pressure Switch 75M04044-HPS-2

- a. KSC-STD-164(D), Standard Environmental Test Methods for Ground Support Equipment Installations at ~~Cape~~ Kennedy
- b. NASA Drawing A75M04044-HPS-2
- c. Cleaning Standard MSFC-STD-164
- d. Test Plan CCSD-FO-1107-1F, Revision C
- e. Test procedure TP-RE-CCSD-FO-1107-2F

1.4 SPECIMEN ASSIGNMENT NUMBERS

The specimen assignment numbers are as follows:

Specimen	Serial Number	Manufacturer's Part Number
1	001	32067
2	002	32067
3	003	32067

SECTION II

RECEIVING INSPECTION

21 TEST REQUIREMENTS

Each specimen shall be visually and dimensionally inspected for conformance with the applicable specification⁸ prior to testing.

22 TEST PROCEDURE

A visual and dimensional inspection was performed to determine compliance with NASA drawing 75MO4044-HPS-2 and to the applicable vendor drawings, to the extent possible without disassembly of the test specimens. At the same time, each test specimen was also inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

The specimens were found to conform with all applicable drawings and specifications.

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

3.1.1 The test specimens shall be pressurized to 250 psig for 10 minutes, using gaseous helium.

3.1.2 The test specimens shall be inspected for leakage and external damage.

3.2 TEST PROCEDURE

3.2.1 The test setup was assembled as shown in figure 3-1, using the equipment listed in table 3-1.

3.2.2 The test specimen was pressurized to the rated proof pressure by closing hand valve 5 and adjusting pressure regulator 3.

3.2.3 The specimens were checked for leakage during the 10 minute period by monitoring gage 4 for an indication of a pressure drop at the specimen. The initial and final pressures were recorded.

3.2.4 Pressure regulator 3 was closed and hand valve 5 was opened to depressurize the specimens.

3.2.5 The specimens were removed from the test setup and inspected for damage.

3.3 TEST RESULTS

There was no leakage of the test specimens and there was no evidence of internal or external damage.

3.4 TEST DATA

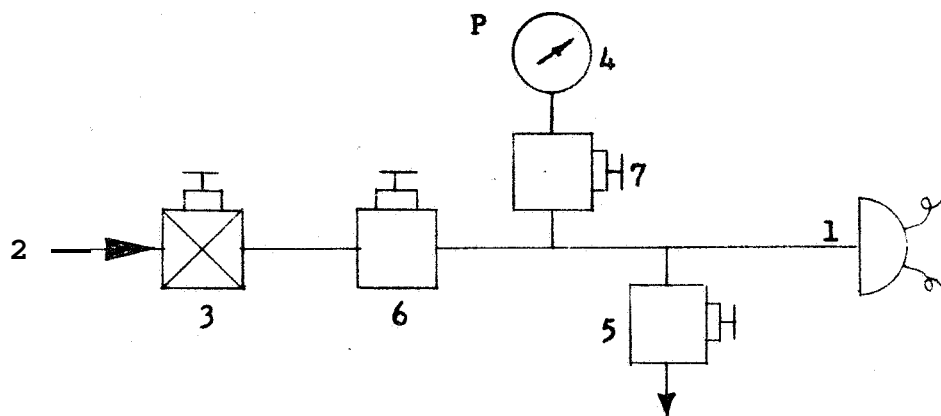
The test data presented in table 3-2 were recorded during the test.

Table 3-1. Proof Pressure Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimens	Hydra-Electric Co.	32067	001, 002, and 003	Pressure Switch
2	Helium Supply	NA	NA	NA	250 psig
3	Pressure Regulator	Tescom Corp.	26-1002	1009	500 psig
4	Pressure Gage	Heise	H 35225	012448	0-to 1000-psig +0.1% FS cal date 5-3-67
5	Relief Valve	Robbins	ANA 250- 4T	NA	$\frac{1}{4}$ -in.
6	Hand Valve	Robbins	ANA 250- 4T	NA	$\frac{1}{4}$ -in.
7	Hand Valve	Robbins	ANA 250- 4T	HA	$\frac{1}{4}$ -in.

Table 3-2. Proof Pressure Test Data

Specimen Number	Pressure (psig)	Time (minutes)	Leakage	External Damage
1	250	10	None	None
2	250	10	None	None
3	250	10	None	None



Note: Refer to table 3-1 for item identification.
All line sizes $\frac{1}{4}$ -inch.

Figure 3-1. Proof Pressure Test Schematic

SECTION IV

FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

- 4.1.1 Actuation of the test specimen shall occur ~~an~~ decreasing pressure at **8.0 (+0.08)** psig.
- 4.1.2 Deactuation ~~of the~~ test specimen shall occur ~~on~~ increasing pressure either at or before **8.80** psig.
- 4.1.3 Contact voltage drop ~~across~~ the normally open ~~and~~ the normally closed contacts shall not exceed 300 millivolts ~~when a 5-ampere, 28-vdc resistive load is applied to the contacts (contacts in closed position).~~
- 4.1.4 The insulation resistance, ~~When measured between all nonconnected pins and between each pin and the case,~~ shall not be less than 20 megohms with **500-vdc** applied.
- 4.1.5 The dielectric strength shall be such that the leakage current shall not exceed 5 milliamperes when **1000 vac (rms)**, 60 cps is applied.
- 4.1.6 The seal leakage rate shall not exceed **2.9×10^{-4}** standard cc of helium/second/inch of seal at a pressure differential. ~~of 1 atmosphere.~~
- 4.1.7 The test specimen shall be adjustable to plus or minus 10 percent ~~of the factory setting.~~

4.2 TEST PROCEDURE

- 4.2.1 The test setup ~~was~~ assembled ~~as~~ shown in figures 4-1 and 4-2, using ~~all~~ the equipment listed in table 4-1 except items 9 through 13.
- 4.2.2 Hand valve 3 ~~and~~ relief valve 5 were opened ~~and~~ the system ~~was~~ purged ~~of air using a low flow from the regulated source.~~
- 4.2.3 Relief valve 5 ~~was~~ closed ~~and~~ the regulated source pressure ~~was~~ slowly increased until the specimen deactuated. The deactuation pressure ~~was~~ recorded.
- 4.2.4 The regulated source pressure ~~was~~ slowly decreased until the specimen actuated. The actuation pressure ~~was~~ recorded and the pressure ~~was~~ reduced to aero.
- 4.2.5 Steps 4.2.3 ~~and 4.2.4~~ were repeated until each test specimen ~~was~~ actuated ~~and~~ deactuated five times.
- 4.2.6 Lamps 7 ~~and 8~~ were ~~removed~~ from the test setup and replaced with load banks 12 which were adjusted to **5** ampere loads at **28** vdc.

- 4.2.7 The differential voltmeter **9** was connected across pins **A** and **B** of **J1**, **and** the contact voltage drop across the normally open contacts **was** measured and recorded.
- 4.2.8 The differential voltmeter was disconnected **and** the regulated source pressure was slowly increased until the specimen de-actuated.
- 4.2.9** Differential voltmeter **9** was connected across pins **B** and **C** of **J1** and the contact voltage drop across the normally closed contacts was measured **and** recorded.
- 4.2.10 The electrical portions of the test setup were removed by disconnecting **P1** (figure **4-2**) and the regulated source pressure **was** reduced to zero.
- 4.2.11 Megohmmeter **11** **was** connected to pins **B** and **C** of **J1**, and with 500 vdc applied to the pins the insulation resistance was measured and recorded.
- 4.2.12 Megohmmeter **11** was connected to pins **A** and **B** of **J1** and the test specimen **was** deactuated. The 500 vdc test voltage was applied and the insulation resistance **was** measured and recorded.
- 4.2.13 The insulation resistance between each pin of **J1** and the test specimen case was measured and recorded by applying 500 vdc between the pins and case.
- 4.2.14 The megohmmeter was removed and the insulation tester **10** was connected between pins **A** and **C** of **J1** and the specimen case with the test specimen in the deactuated position.
- 4.2.15 The test voltage was gradually increased from zero to 1000 vac (rms) and was maintained for 60 seconds. The highest leakage current was recorded.
- 4.2.16 The regulated source pressure was reduced to zero and the insulation tester **was** connected between pins **C** and **A** of **J1** **and** the specimen case. Step 4.2.15 was then repeated.
- 4.2.17 The test specimen was placed in vacuum chamber **3** and the chamber **was** then evacuated to **maximum** vacuum.
- 4.2.18 Helium was applied **to** the inlet **of** the test specimen to create **a** differential pressure of one atmosphere between the specimen and the vacuum chamber.
- 4.2.19 Mass spectrometer **2** **was** used to measure helium leaking **from** the test specimen **.**
- 4.2.20 The vacuum chamber was returned to ambient conditions **and** the test specimen **was** removed.
- 4.2.21 The test specimen was connected into the test setup **as** specified in 4.2.1.

- 4.2.22 The adjustment screw **was** turned **fully** counterclockwise and the maximum operating pressures were **measured and** recorded.
- 4.2.23 The adjustment screw **was** then turned **fully** clockwise and the minimum operating pressures were **measured and** recorded.
- 4.2.24 The test specimen **was reset** to the specified actuation pressure setting ■
- 4.3 TEST RESULTS
- 4.3.1 Specimens 1, 2, and 3 actuated above the levels specified in 4.1.1. The units were reset to the specification levels after the **adjustability** test ■
- 4.3.2 The contact voltage **drop** was less than 300 millivolts for **all** measurements,
- 4.3.3 The insulation resistance **was** greater than 20 megohms **for** all measurements ■
- 4.3.4 The dielectric strength (leakage current) was less than 5 milli-amperes **for all** measurements.
- 4.3.5 Specimen seal leakage **was** less than 2.9×10^{-4} standard cc of helium/second/inch of seal.
- 4.3.6 The test specimens were adjustable to the levels specified in 4.1.7.
- 4.4 TEST DATA
- Data recorded during the initial functional test are presented in tables 4-2 and 4-3.

Table 4-1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimens 1, 2, and 3	Hydra-Electric Company	32067	001, 002 and 003	Pressure Switch
2	Regulated Helium Source	NA	NA	NA	Lo-psig
3	Hand Valve	Grove	10903A	NA	$\frac{1}{4}$ -in.
4	Pressure Gage	Wallace-Tierman	FA 234	HH 11924	0-to 50-psig $\pm 0.1\%$ FS Cal date 3-20-67
5	Relief Valve	Robbins	ANA 250-4T	NA	$\frac{1}{4}$ -in.
6	Power Source	Lambda	LA5003B	010270	28-vdc, 5 amperes
7	Lamp (DS1)	General Electric	327	NA	Green
8	Lamp (DS2)	General Electric	327	NA	Orange
9	Differential Voltmeter	John Fluke	821A	156	$\pm 0.1\%$ FS
10	Insulation Tester	Wiley	5	015241	
11	Megohmmeter	General Radio	1862-B	01845	
12	Load Bank	CCSD	NA	NA	5-ampere, 28-vdc
13	Ammeter	Simpson	NA	NA	0-to 10-ampere 1% FS

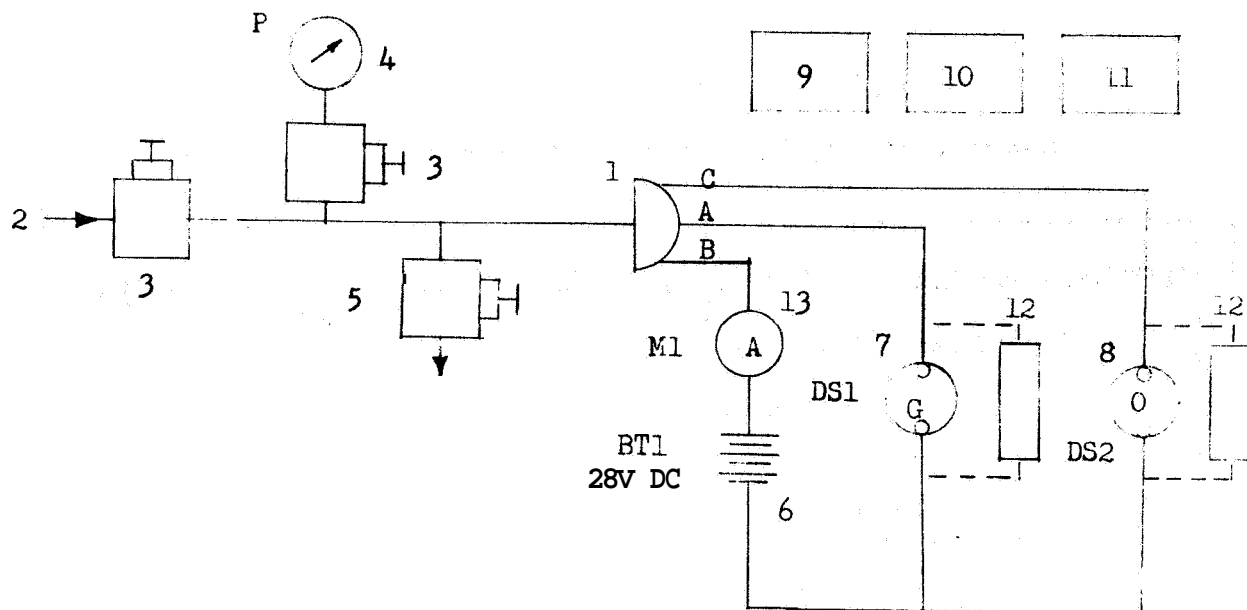
Table 4-2. Initial Functional Test Operating Pressures

SPECIMEN NUMBER	SERIAL NUMBER	AVERAGE ACTUATION PRESSURE (psig)	SPECIFIED ACTUATION PRESSURE (psig)	AVERAGE DEACTUATION PRESSURE (psig)	SPECIFIED DEACTUATION PRESSURE (psig max.)
1	001	*8.20	8.0 (+0.08)	8.60	8.80
2	002	*8.26	8.0 (+0.08)	8.70	8.80
3	003	*8.29	8.0 (+0.08)	8.54	8.80

* Out of tolerance

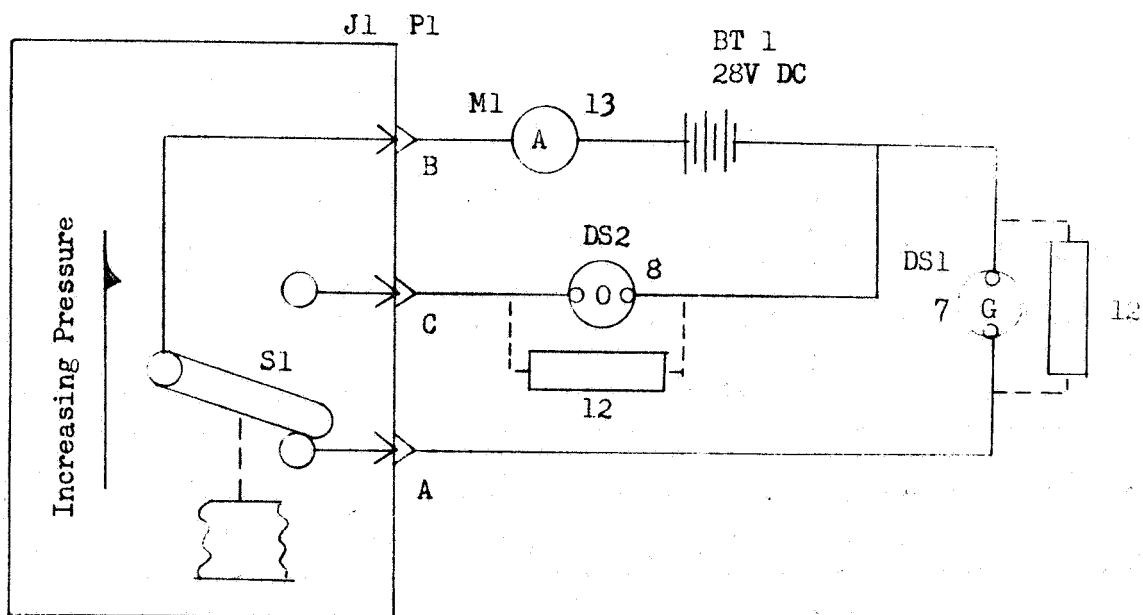
Table 4-3. Initial Functional Adjustability Test Data

SPECIMEN NUMBER	SERIAL NUMBER	MAXIMUM ACTUATION PRESSURE (psig)	SPECIFIED ACTUATION PRESSURE (psig min.)	MINIMUM ACTUATION PRESSURE (psig)	SPECIFIED ACTUATION PRESSURE (psig max.)
1	001	8.95	8.80	7.05	7.20
2	002	9.00	8.80	7.05	7.20
3	003	8.80	8.80	7.20	7.20



Note: Refer to table 4-1 for item identification,
All lines $\frac{1}{4}$ inch.

Figure 4-1. Functional Test Schematic



Note: Refer to table 4-1 for item identification.
All lines $\frac{1}{4}$ inch.

Figure 4-2. Functional Test Wiring Schematic

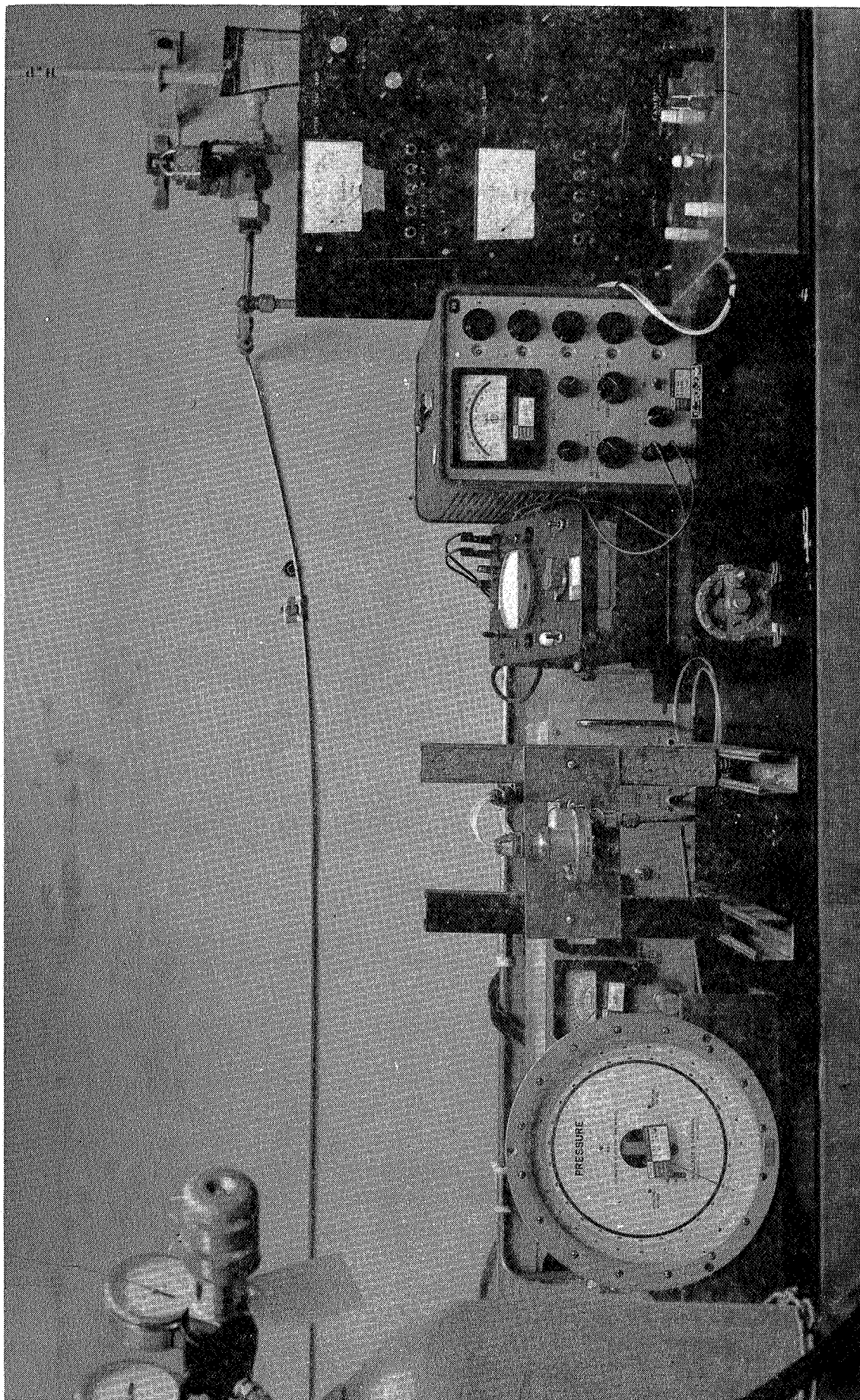


Figure 4-3. Functional Test Setup

SECTION V

LOW TEMPERATURE TEST

5.1 TEST REQUIREMENTS

- 5.1.1 Test specimens 1 and 2 shall be subjected to a low temperature test of 30 (+0, -4)°F to determine whether the environment causes degradation or deterioration of the specimens.
- 5.1.2 A functional test as prescribed in section IV shall be performed before the test (if more than 72 hours has elapsed since the last functional test), during the test, and within 1 hour after stabilization at ambient temperature after the test. Paragraphs 4.1.6 and 4.1.7 may be omitted.

5.2 TEST PROCEDURE

- 5.2.1 The test specimens were placed in the low temperature chamber and all necessary electrical and pneumatic systems were connected.
- 5.2.2 A functional test was performed according to section IV. Paragraphs 4.1.6 and 4.1.7 were omitted.
- 5.2.3 The chamber temperature was decreased at the rate of one degree per minute and stabilized at 30 (+0, -4)°F.
- 5.2.4 A functional test (refer to 5.1.2) was performed when temperature stabilization was attained.
- 5.2.5 The chamber temperature was returned to ambient upon completion of the functional test.
- 5.2.6 The test specimens were visually inspected and functionally tested within 1 hour following the return to ambient.

5.3 TEST RESULTS

Test specimens 1 and 2 operated properly during the Functional tests and there was no apparent deterioration or degradation.

5.4 TEST DATA

Data recorded during the low temperature functional tests are presented in table 5-1.

Table 5-1. Low Temperature Functional Test Operating Pressures

Temperature Test	Specimen 1		Specimen 2	
	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)
Before	7.92	8.42	7.92	8.52
During	8.02	8.52	7.98	8.64
After	8.02	8.42	8.02	8.42

Specification Levels

Actuation: 8.0 (± 0.08) psig

Deactuation: 8.80 psig maximum

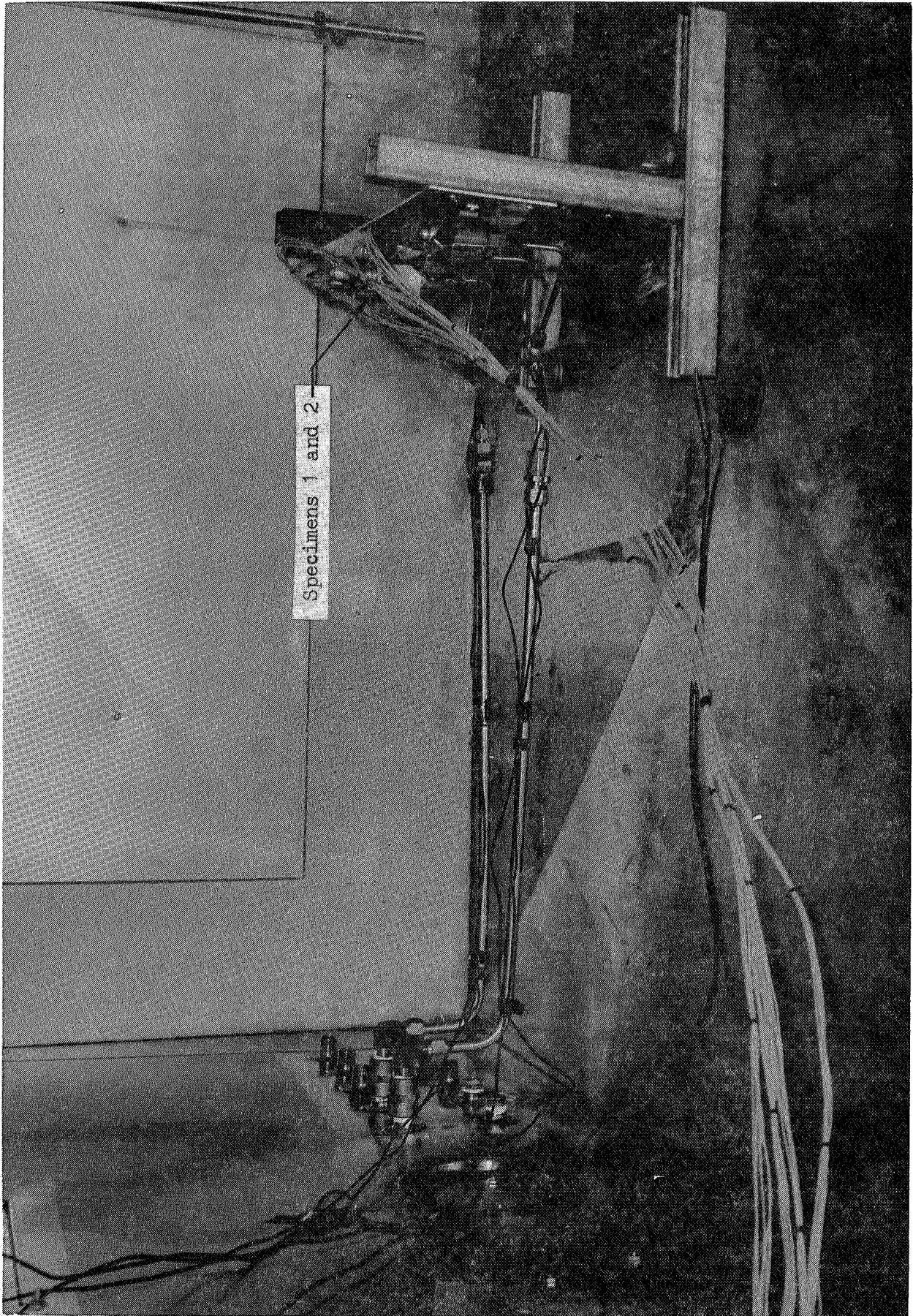


Figure 5-1. Temperature Test Setup

SECTION VI

HIGH TEMPERATURE TEST

6.1 TEST REQUIREMENTS

- 6.1.1 Test specimens 1 and 2 shall be subjected to a high temperature test of 130 (+4, -0)°F to determine Whether the environment causes degradation or deterioration of the specimens.
- 6.1.2 A functional test as prescribed in section IV shall be performed before the test (if 72 hours has elapsed since the last functional test), during the test, and Within 1 hour after stabilizati~~on~~at ambient temperature after the test. Paragraphs 4.1.6 and 4.1.7 may be omitted,

6.2 TEST PROCEDURE

- 6.2.1 The test specimens were placed in the high temperature chamber and all necessary electrical and pneumatic systems were connected.
- 6.2.2 A functional test was performed according to section IV. Paragraphs 4.1.6 and 4.1.7 were omitted.
- 6.2.3 The chamber temperature was increased at the rate of one degree per minute and stabilized at 130 (+4, -0)°F.
- 6.2.4 A functional test (refer to 6.1.2) was performed when temperature stabilization was attained.
- 6.2.5 The chamber temperature was returned to ambient upon completion of the functional test.
- 6.2.6 The test specimens were visually inspected and functionally tested within one hour following the return to ambient.

6.3 TEST RESULTS

- 6.3.1 The actuation pressures of specimens 1 and 2 were out of tolerance after the temperature test.
- 6.3.2 There was no apparent degradation or deterioration of the specimens.

6.4 TEST DATA

Data recorded during the high temperature functional tests are presented in table 6-1.

Table 6-1. High Temperature Functional Test Operating Pressures

Temperature Test	Specimen 1		Specimen 2	
	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)
Before	8.02	8.48	8.02	8.56
During	7.92	8.36	8.04	8.52
After	*8.10	8.52	*8.09	8.67

* Out of tolerance

Specification Levels

Actuation: 8.0 (± 0.08) psig

Deactuation: 8.80 psig maximum

SECTION VII

VIBRATION TESTS

7.1 TEST REQUIREMENTS

- 7.1.1 Test specimens 1 and 2 shall be subjected to sinusoidal and random excitation to determine the capability of the specimens to operate satisfactorily during and after vibration testing.
- 7.1.2 The tests shall be performed in the horizontal and vertical axes (see figure 7-1).
- 7.1.3 The tests shall be conducted in accordance with section 9, procedure I of KSC-STD-164(D).
- 7.1.4 Acceleration shall be measured by accelerometers mounted on the test specimens.
- 7.1.5 The specimens shall be monitored for contact chatter during the sinusoidal sweep and random excitation tests.
- 7.1.6 A functional test shall be performed prior to the vibration tests and immediately following the sinusoidal sweep and random excitation test in each axis.

7.2 TEST PROCEDURE

- 7.2.1 The test specimens were installed on a vibration fixture and the fixture was mounted on the vibrator. All necessary electrical and pneumatic systems were connected.
- 7.2.2 A functional test was performed according to section IV. Paragraphs 4.1.6 and 4.1.7 were omitted.
- 7.2.3 The resonant frequency search was performed while vibrating the test specimens at the input levels specified in table 7-1.
- 7.2.4 The sinusoidal sweep test was performed by vibrating the test specimens at the levels specified in table 7-1. The specimen contacts were monitored for chatter with the test specimen pressurized from 10 to 2000 cps and depressurized from 2000 to 10 cps.
- 7.2.5 A functional test was performed according to section IV. Paragraphs 4.1.6 and 4.1.7 were omitted.
- 7.2.6 The random excitation test was performed by vibrating the test specimens at the levels specified in table 7-1. The specimen contacts were monitored for chatter with the test specimen pressurized for 2.5 minutes and depressurized for 2.5 minutes.
- 7.2.7 A functional test was performed according to section IV. Paragraphs 4.1.6 and 4.1.7 were omitted except after the 2-axis random test when 4.1.6 was performed.

7.3

TEST RESULTS

7.3.1

Test specimen 1 operated properly during **all** the functional tests. Specimen 2 actuated above the level specified in paragraph 4.1.1 after the **Y-axis and Z-axis** random excitation tests. The specimens were not readjusted after each functional test.

7.3.2

No contact chatter was detected during the vibration tests.

7.4

TEST DATA

7.4.1

Data recorded during the vibration functional tests are presented in tables 7-2 and 7-3.

7.4.2 -

A typical sinusoidal input plot (acceleration versus frequency) is presented in figure 7-2.

7.4.3

A typical random equalization plot **is** presented **in** figure 7-3.

Table 7-1. Vibration Test Levels

Resonant Frequency Search 15 Minute Duration		Sinusoidal Sweep 20 Minute Duration		Random Excitation 5 Minute Duration	
Frequency (cps)	Level	Frequency (cps)	Level	Frequency (cps)	Level
5 to 44	0.01-inch DA	10 to 44	0.1-inch DA	10 to 100	+6 db/octave
44 to 2000	1.0g peak	44 to 2000	10.0g peak	100 to 1000	0.01g ² /cps
2000 to 44	1.0g peak	2000 to 44	10.0g peak	1000 to 2000	-6 db/octave

**Table 7-2. Functional Test Operating Pressures Obtained
Before the Vibration Tests**

Specimen Number	Serial Number	Average Actuation Pressure (psig)	Specified Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Specified Deactuation Pressure (psig max)
1	001	8.02	8.0 (± 0.08)	8.47	8.80
2	002	8.02	8.0 (± 0.08)	8.53	8.80

Table 7-3. Vibration Functional Test Operating Pressures

Test Axis	Test	Specimen 1		Specimen 2	
		Average Actuation (psig)	Average Deactuation (psig)	Average Actuation (psig)	Average Deactuation (psig)
X	Sine	8.04	8.47	8.02	8.53
	Random	8.04	8.47	8.07	8.57
Y	Sine	8.02	8.45	8.07	8.57
	Random	8.02	8.42	*8.12	8.60
Z	Sine	7.96	8.47	8.02	8.52
	Random	7.95	8.32	*8.12	8.52

* Out of tolerance

Specification Levels

Actuation: 8.0 (± 0.08) psig

Deactuation: 8.80 psig maximum

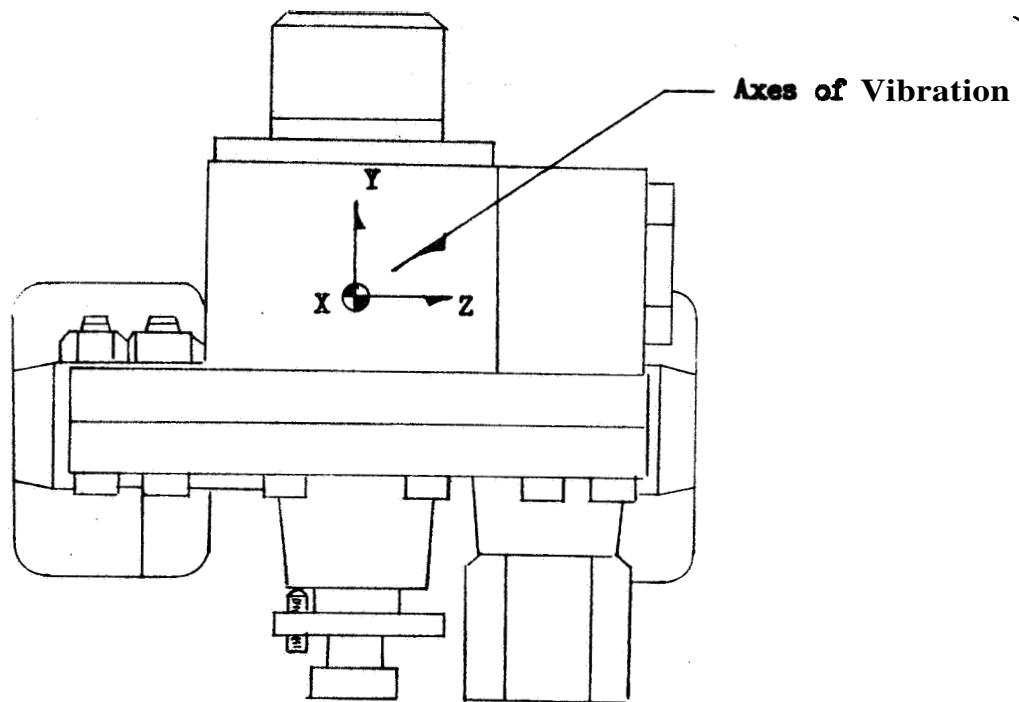


Figure 7-1. Axes of Vibration

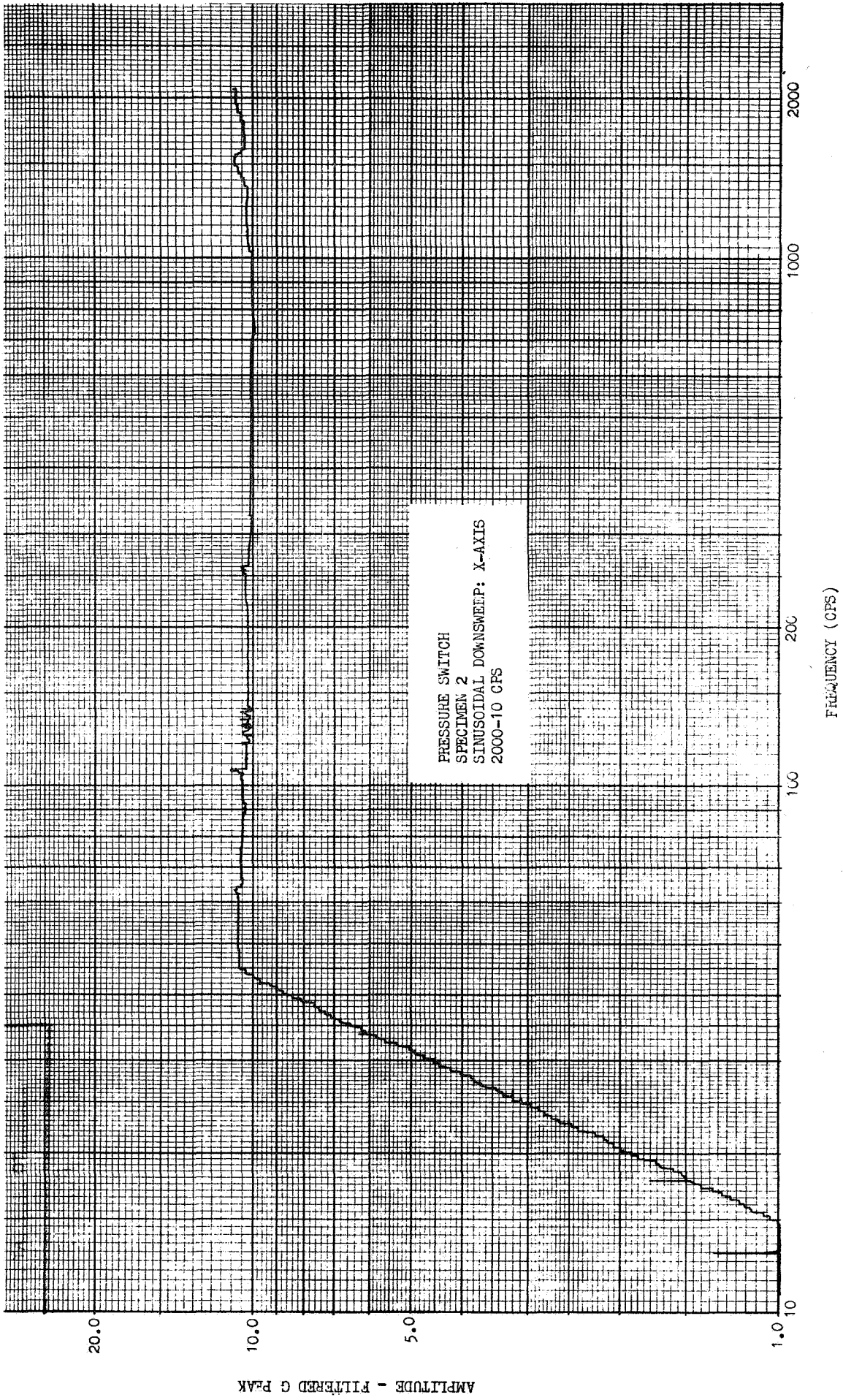


Figure 7-2. Typical Vibration. Input Plot (Control Accelerometer)

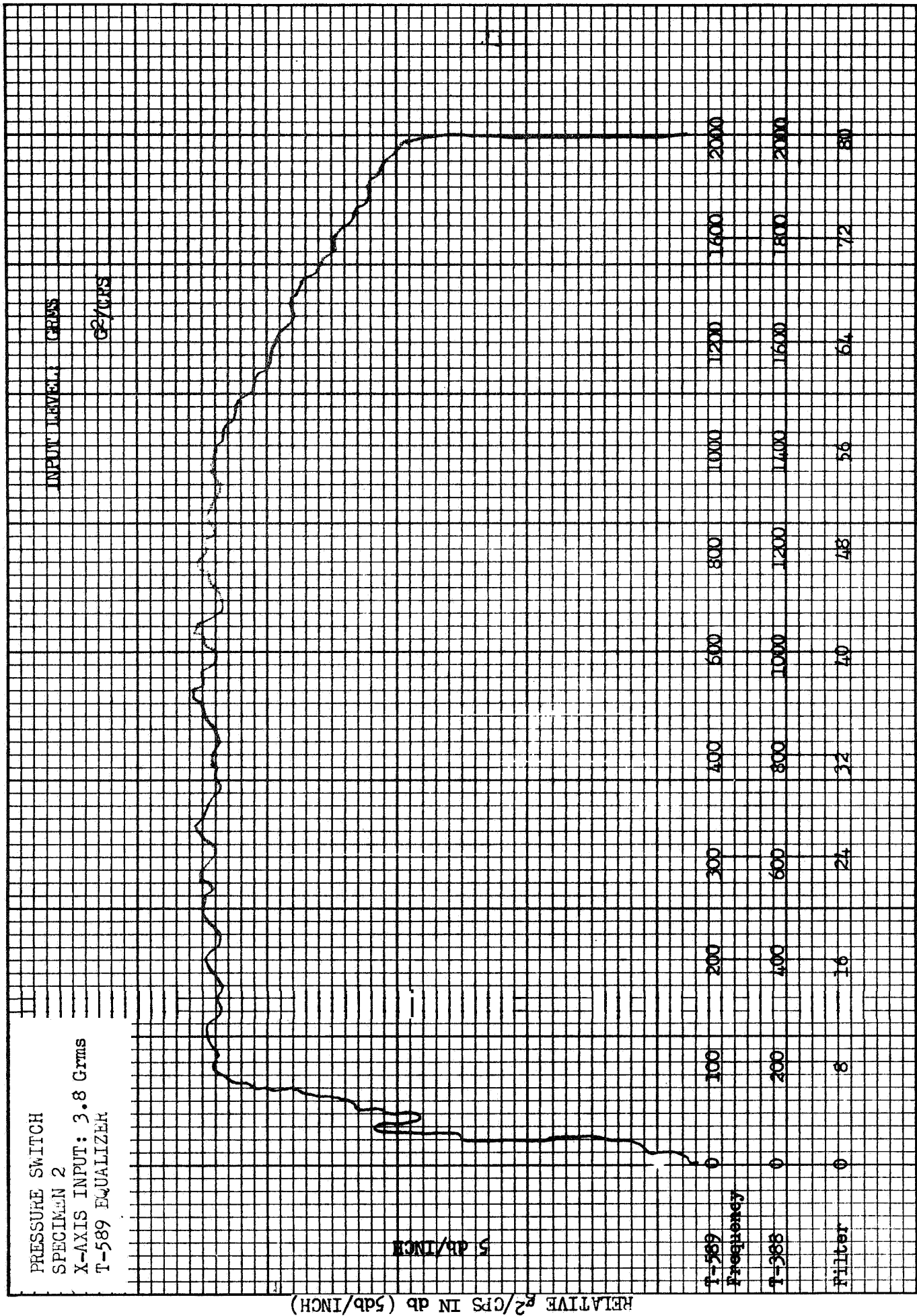


Figure 7-3. Typical Random Equalization Plot

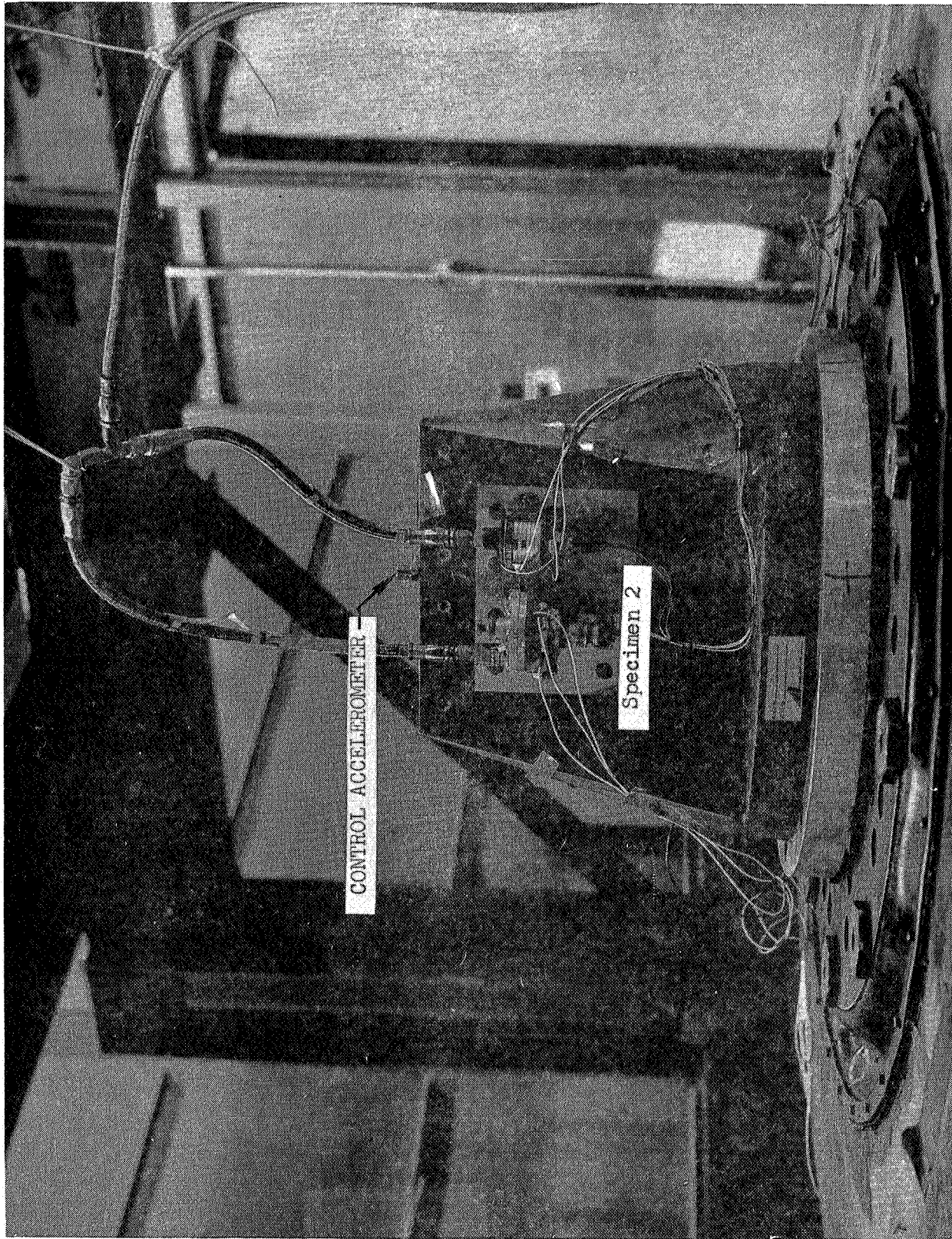


Figure 7-4. Vibration Test Setup (Specimen 2, Y-axis)

SECTION VIII

SALT FOG TEST

8.1 TEST REQUIREMENTS

- 8.1.1 Test specimens 1 and 3 ~~shall be~~ subjected to a salt fog test to ~~determine~~ the extent, if ~~any~~, of the degradation ~~or~~ deterioration resulting ~~from~~ the environment exposure.
- 8.1.2 The salt solution ~~shall be~~ a 5 percent by weight mixture ~~and~~ ~~'shall have~~ a pH factor ~~of~~ 6.5 to 7.2. Test temperature ~~shall be~~ 95 (+2, -4)°F.
- 8.1.3 A functional test ~~as~~ prescribed in section IV shall be performed prior to exposure (if more than 72 hours ~~has~~ elapsed since the last functional test) ~~and~~ within 1 hour after removal ~~from~~ the salt fog environment.

8.2 TEST PROCEDURE

- 8.2.1 The test specimens were inspected for corrosion, ~~dirt~~, and oily films prior to the salt fog test ~~and~~ were cleaned before being ~~installed~~ in the salt fog chamber,
- 8.2.2 The test specimens were placed in the chamber in a ~~manner~~ which would permit the fog to reach all side8 of the spechens without condensate dripping on them.
- 8.2.3 The specimens were exposed to the salt fog atmosphere for 240 hours.
- 8.2.4 A functional test was perforced according to section IV. Paragraph 4.1.6 was omitted.
- 8.2.5 The test specimens ~~were~~ inspected for corrosion caused by exposure to the salt fog atmosphere.

8.3 TEST RESULTS

- 8.3.1 Rust ~~was~~ present on the electrical connectors of both specimens. No corrosion ~~was~~ detected.
- 8.3.2 Test specimen 1 operated properly after the salt fog test. Test specimen 3 actuated below the level specified in 4.1.1 ~~after~~ the salt fog test,
- 8.3.3 The ~~maximum~~ actuation pressure of specimen 3 ~~was~~ below the level specified in 4.1.7 for the adjustability test.

8.4 TEST DATA

Data recorded during the salt fog functional tests ~~are~~ presented in tables 8-1 and 8-2.

Table 8-1. Salt Fog Functional Test Operating Pressures

Salt Fog Test	Specimen 1		Specimen 3	
	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)
Before	7.95	8.32	8.00	8.25
After	7.93	8.34	*7.73	8.49

* Out of tolerance

Specification Levels

Actuation: 8.0 (± 0.08) psig

Deactuation: 8.80 psig maximum

Table 8-2. Adjustability Test Data Obtained After Salt Fog Test

Specimen Number	Serial Number	Maximum Actuation Pressure (psig)	Specified Actuation Pressure (psig min)	Minimum Actuation Pressure (psig)	Specified Actuation Pressure (psig max)
1	001	9.02	8.80	6.92	7.20
2	002	9.02	8.80	7.22	7.20
3	003	*8.52	8.80	7.02	7.20

* Out of tolerance



Figure 8-1. Salt Fog Test Setup

SECTION IX

EXPLOSION TEST

9.1 TEST REQUIREMENTS

- 9.1.1 Test specimens 1 and 2 shall be subjected to an explosion test (ignition proof test) to determine the explosion-producing characteristics of the specimens when operated in an explosive atmosphere.
- 9.1.2 The explosive mixture shall be composed of 32 (± 5) percent by volume of hydrogen-in-air and the test chamber pressure shall be 13.1 psig at a temperature of 130 (-4 , $+2$)°F.
- 9.1.3 The specimens shall be operated while in the explosive atmosphere.
- 9.1.4 A functional test shall be performed prior to and at the completion of the test. Paragraphs 4.1.6 and 4.1.7 may be Omitted.

9.2 TEST PROCEDURE

- 9.2.1 The specimens were placed in the test chamber and all necessary electrical and pneumatic systems were connected as shown in figure 4-1.
- 9.2.2 The temperature within the test chamber was stabilized at 130°F and the pressure was decreased to 13.1 psia.
- 9.2.3 The explosive atmosphere was injected into the chamber and the internal pressure was adjusted to 13.1 psia.
- 9.2.4 The specimens were actuated and deactuated 10 times while in the explosive atmosphere.
- 9.2.5 The explosive atmosphere was verified and the chamber pressure was adjusted to 14.7 psia. Paragraph 10.2.4 was repeated.
- 9.2.6 The explosive atmosphere was verified and the chamber was purged with gaseous nitrogen.

9.3 TEST RESULTS

- 9.3.1 The specimens operated successfully in the specified explosive atmosphere.
- 9.3.2 Specimen 1 operated properly during the functional test performed after the explosion test. Specimen 2 actuated below the level specified in 4.1.1.

9.4 TEST DATA

Data recorded during the explosion test functional tests are presented in table 9.1.

Table 9-1. Explosion Test Functional Operating Pressures

Explosion Test	Specimen 1		Specimen 2	
	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Average Actuation Pressure (psig)	Average Deactuation Pressure (psig)
Before	8.02	8.52	8.01	8.72
After	8.03	8.42	*7.84	8.25

* Out of tolerance

Specification Levels

Actuation: 8.0 (5.08) psig

Deactuation: 8.80 psig maximum

SECTION X

CYCLE TEST

10.1 TEST REQUIREMENTS

- 10.1.1 Test specimens **1 and 2** shall be subjected to **5000** cycles of operation. A cycle shall consist of one actuation and one deactuation of the specimen,
- 10.1.2 The contacts of each specimen shall have a **28-vdc, 5-ampere** resistive load applied during the cycle test.
- 10.1.3 A functional test as prescribed in section IV shall be performed prior to the cycle test (if more than **72** hours has elapsed since the last functional test) and following each **1000** cycles of operation. Paragraphs 4.1.6 and 4.1.7 may be omitted except for the last functional test,

10.2 TEST PROCEDURE

- 10.2.1 The test setup was assembled as shown in figures **10-1** and **10-2** using the equipment listed in table **10-1**.
- 10.2.2 The resistive load⁸ were adjusted to limit the current through the specimen contacts to **5** amperes.
- 10.2.3 The repeat cycle **timers** were adjusted so that the specimens were actuated for **3 seconds** and deactuated for **3 seconds** during each cycle.
- 10.2.4 Pressure regulator **3** was adjusted to limit the pressure to **10 psig**.
- 10.2.5 The test specimens were monitored for proper operation using event recorder **8**,
- 10.2.6 A functional test was performed after each **1000** cycles of operation.

10.3 TEST RESULTS

- 10.3.1 Each specimen actuated and deactuated during each cycle of operation.
- 10.3.2 Specimen **1** did not operate within the specified limits during the functional tests performed after **one, two, three, and four** thousand cycles of operation.
- 10.3.3 Specimen **2** did not operate within the specified limits during the functional test performed after **5000** cycles of operation,
- 10.3.4 Specimens **1 and 2** were adjustable to the levels specified in **4.1.7**.

10.4

TEST DATA

Data recorded during the cycle test *are* presented in tables 10-2, 10-3, and 10-4.

Table 10-1. Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimens 1 and 2	Hydra Electric Company	32067	001, 002	Pressure Switch
2	Gaseous Nitrogen and Helium	NA	NA	NA	10-psig
3	Pressure Regulator	Grove	15-LX	104859-9	0-to 300-psi
4	Pressure Gage	Wallace-Tierman	PA234	HH11924	0-to 50-psig +0.1% FS Cal date 9-12-67
5	Solenoid Valve	Marotta Valve Corp.	MV100	NA	$\frac{1}{4}$ -in.
6	Solenoid Relief Valve	Marotta valve Corp.	MV109	NA	$\frac{1}{4}$ -in.
7	Repeat Cycle Timers (2)	Industrial Timer Corporation	ET-15S	NA	3-seconds each
8	Event Recorder	Techni-Rite Electronics	TR120	010461	
9	Power Supply	Perkin Electronics	NA	63-293	28-vdc, 10-amps
10	Load Bank	CCSD	NA	NA	5-amp, 28-vdc
11	Ammeter	Simpson	NA	NA	0-to 10-ampere +1% FS (built into load banks)

Table 10-2. Cycle Test Functional Operating Pressures (Specimen 1)

Number of Cycles	Average Actuation Pressure (psig)	Specified Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Specified Deactuation Pressure (psig max)
0	8.00	8.00 (± 0.08)	8-30	8.80
1000	*8.10	8.00 (± 0.08)	8.40	8.80
2000	*8.10	8.00 (± 0.08)	8.40	8-80
3000	*8.10	8.00 (± 0.08)	8.40	8.80
4000	*8.10	8.00 (± 0.08)	8.40	8.80
5000	8.05	8.00 (± 0.08)	8.40	8.80

Out of tolerance

Table 10-3. Cycle Test Functional Operating Pressures (Specimen 2)

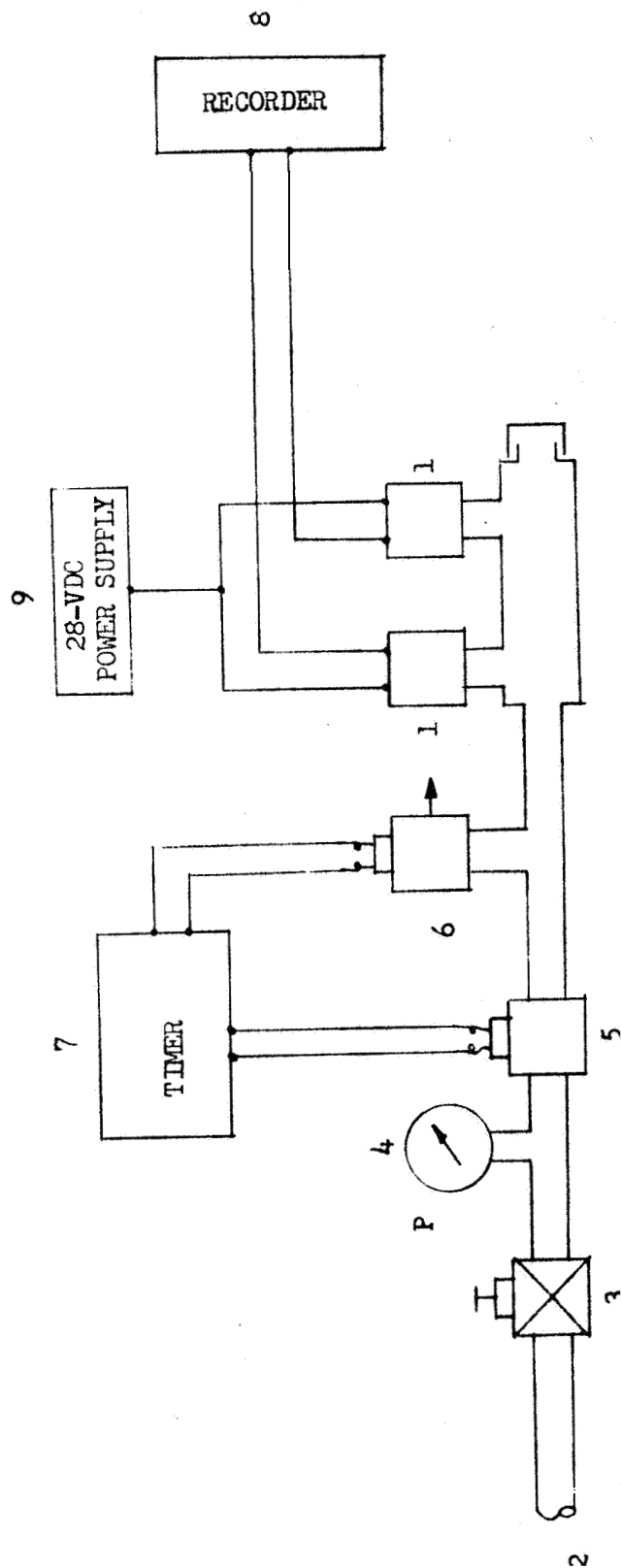
Number of Cycles	Average Actuation Pressure (psig)	Specified Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Specified Deactuation Pressure (psig max)
0	8.00	8.00 (± 0.08)	8.30	8.80
1000	8.00	8.00 (± 0.08)	8.50	8.80
2000	8.00	8.00 (± 0.08)	8.50	8.80
3000	8.00	8.00 (± 0.08)	8.40	8.80
4000	8.00	8.00 (± 0.08)	8.50	8.80
5000	*7.90	8.00 (± 0.08)	8.50	8.80

Out of tolerance

Table 10-4. Adjustability Test Data Obtained *After* Cycle Test

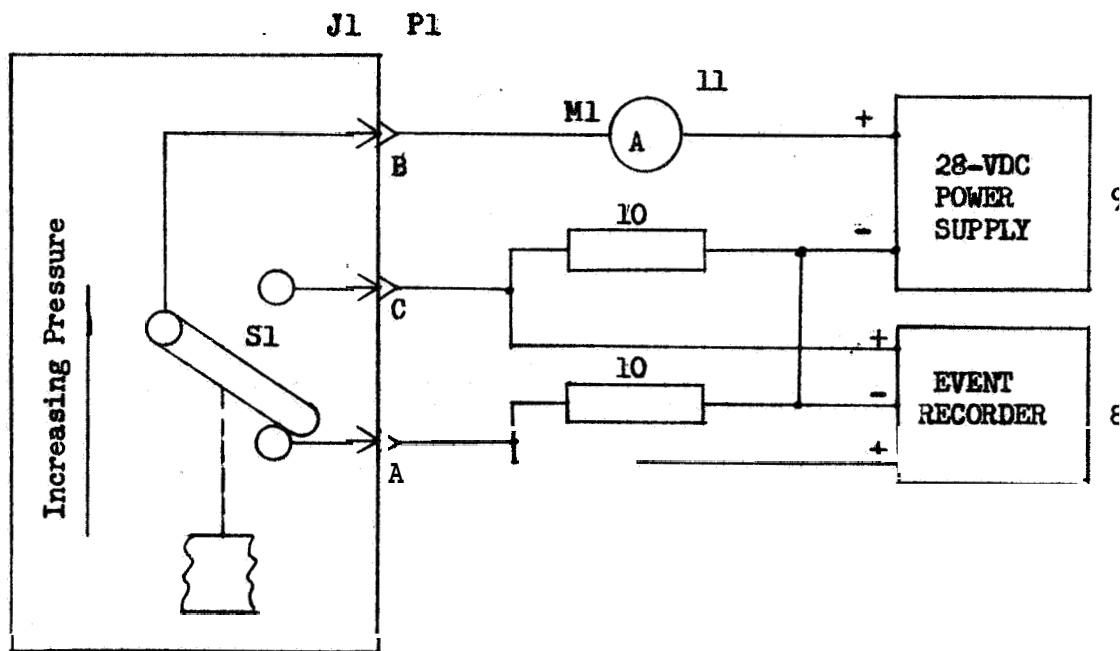
Specimen Number	Serial Number	Maximum Actuation pressure (psig)	Specified Actuation Pressure (psig min)	Minimum Actuation Pressure (psig)	Specified Actuation Pressure (psig max)
1	001	8.90	8.80	7.10	7.20
2	002	9.05	8.80	7.20	7.20
3	003	9.00	8.80	*7.30	7.20

* Out of tolerance



Note: Refer to table 10-1 for item identification.

Figure 10-1. Cycle Test Schematic



Note: Refer to table 10-1 for item identification.

Figure 10-2. Typical Electrical Connection for Cycle Test Schematic

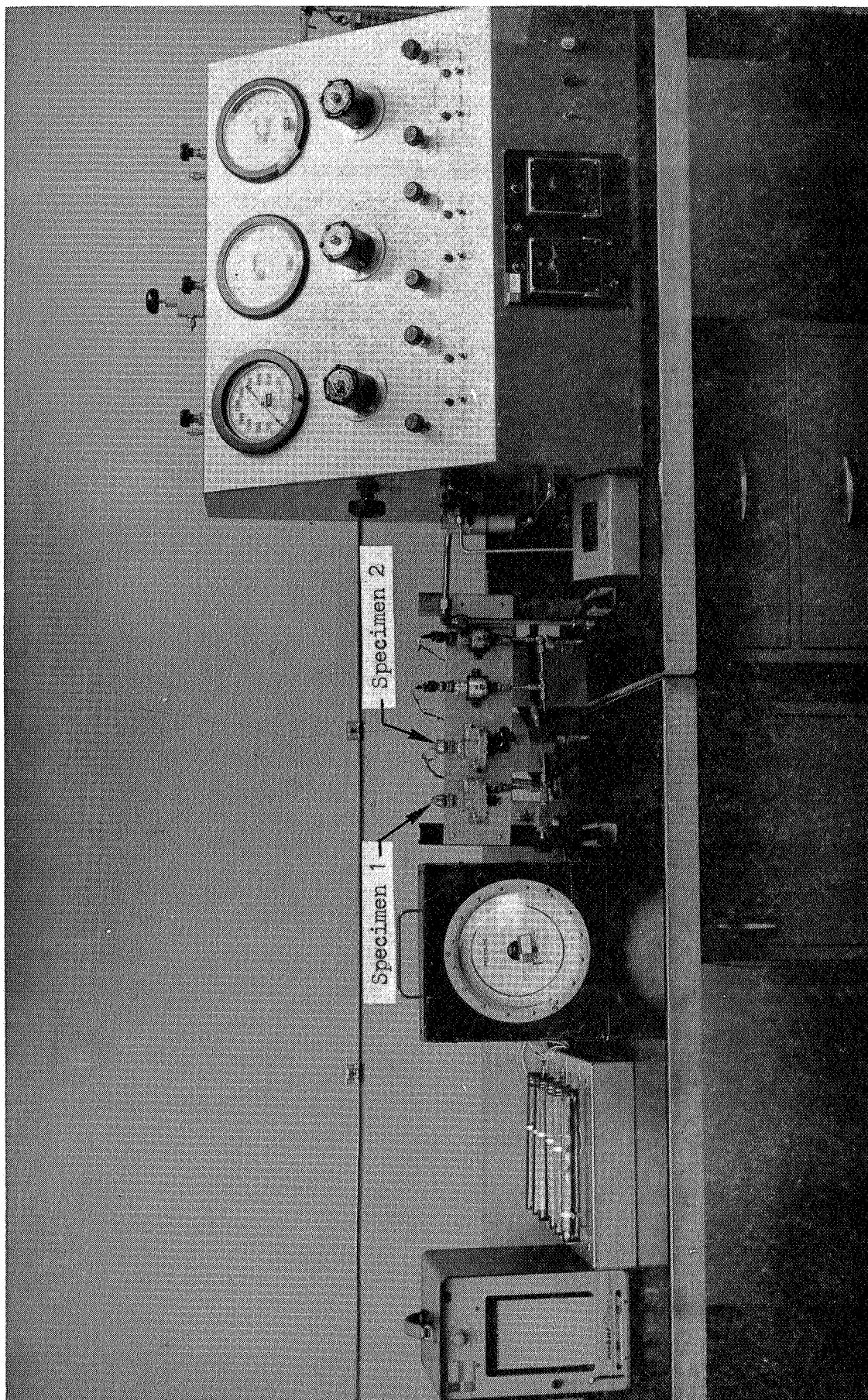


Figure 10-3. Cycle Test Setup

APPROVAL

TEST REPORT

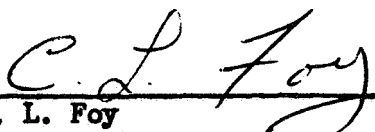
FOR

PRESSURE SWITCH

Hydra Electric Company Part Number 32067

NASA Drawing Number 75M04044-HPS-2


SUBMITTED BY


C. L. Foy
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APPROVALS


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